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ADDRESS

Delivered by the President on Presenting the Gold Medal of the Society to Dr. Benjamin Apthorp Gould.

GENTLEMEN,—

Your Council have awarded the Gold Medal of the Society to Benjamin Apthorp Gould for his *Uranometria Argentina*.

Dr. Gould is an astronomer who has held a leading position amongst the cultivators of our science for many years; and a reference to the "Royal Society's Lists of Scientific Papers" will find him credited with no less than fifty-five papers. These papers treat of almost all branches of our science; and some of them, such as the "Reduction of D'Agelet's Observations," are works of considerable extent and of great value. These works cannot have been without their influence in guiding the decision of your Council in the award of the Medal, but it has been upon Dr. Gould's direction of the work of the Cordoba Observatory that attention has been chiefly concentrated.

The astronomical results contained in the *Uranometria Argentina* constitute but a small, and in my opinion not the most valuable, portion of those which have been obtained by Dr. Gould since he assumed the direction of the Cordoba Observatory; but although the observations for the Southern Zones are understood to have been completed, and one volume of results has already been published, your Council have thought it undesirable to await the complete publication of these results before marking, in the most emphatic manner in their power, their high appreciation of the skill and energy with which Dr. Gould has utilised the resources placed at his disposal by the liberality of the Government of the Argentine Republic.

The work for which the Medal has been chiefly awarded may be considered an extension of Argelander's scale of magnitudes to all the stars which can be seen by a good eye without instrumental aid between 10° North Declination and the South Pole, together with a series of charts exhibiting, on a stereographic projection, the positions of all these stars to the sixth magnitude, and a proposed revision of the boundaries of the southern constellations.

The work is of a class which is not usually undertaken at our principal Observatories, for it requires neither an elaborate instrumental equipment nor that technical skill on the part of the observers which can only be acquired by long continued practice; but Dr. Gould, on his arrival, with four assistants, at Cordoba, in the September of 1870, found that the instruments

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which had been ordered from Europe for the Observatory had not been received; and the disorganisation of scientific matters on the Continent from the war then in progress rendered it probable that there might be some considerable delay before these instruments could be delivered. Under these circumstances Dr. Gould, encouraged by the experience which he had gained, and by the success which had attended a somewhat similar effort, on a smaller scale, made during the mounting of the Transit Circle at the Albany Observatory in 1858, determined to undertake the work for which your Medal is this day awarded.

In the absence of any standard of absolute brightness, the determination of stellar magnitudes can only be relative, and the scale in which they are expressed must be an arbitrary one. The second Herschel, whilst at the Cape, determined the light received from the principal Southern stars in terms of the combined light of α^1 and α^2 *Centauri* as an unit, and he pointed out that by a slight modification of the scale in general use it would be possible to make that scale a photometric one, and the amount of light received inversely proportional to the square of the number which expressed the magnitude. But although some such modification as that proposed by Herschel would be a decided improvement, if the ground were not already preoccupied, yet our conventional system of magnitudes, as practically exhibited with some approach to scientific precision in the *Uranometria Nova*, has received such general acceptance from astronomers that probably Dr. Gould was well advised in adopting it for his Southern Uranometria. To secure consistency between the estimations of magnitude by the different observers and the practical adoption of Argelander's scale, and its extension to stars of the seventh magnitude, Dr. Gould selected, from the *Uranometria Nova*, 1800 stars between the parallels of 5° and 15° North Declination which culminated at nearly the same altitudes at Bonn and at Cordoba. The magnitudes of these stars were estimated by all the four observers to whom the work at Cordoba was to be entrusted, and the results obtained were carefully compared with the magnitudes of the *Uranometria Nova* and, I presume, in cases of discordances reconsidered. It was found that the estimations of the four observers were in perfect accord, to tenths of a magnitude, in the case of 722 of these stars; in the other cases the discordances did not usually exceed the tenth of a magnitude and never exceeded two-tenths, except in cases where there were peculiarities of colour or the presence of some companion star to disturb the estimations. Dr. Gould determined to adopt as his standards of magnitude only those stars upon which the agreement of the four observers was perfect.

But to facilitate the comparisons of the Southern stars with these standards, stars in two regions south of Declination 55° were selected and carefully compared by all the four observers with the standards in the principal type-belt, and thus a secondary set of standards, more conveniently situated for direct

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comparison with the Southern stars, was established. The work was then distributed among the four observers, and appears to have been completed about the end of the year 1873.

It will give some indication of the magnitude of the work when I mention that the number of estimations made for the formation of the *Uranometria Argentina* exceeded 46,000.

These estimations of stellar magnitude must be considered as the corpus of the work for which your Medal has been awarded, but Dr. Gould has carefully discussed the results, and compared them with nearly all the materials which were available for the purpose, and, in particular, he has compared his estimations of the magnitude of the brighter stars with results obtained from a discussion of the photometric observations of the second Herschel and of Seidel. The results of this comparison are generally satisfactory, although there appear some slight indications of a change of scale within the range of the four magnitudes compared with Herschel's measures.

The comparison of the Cordoba magnitudes with those of Lacaille, Herschel, and other astronomers, has revealed some cases of marked discordance; but as Dr. Gould has had the great advantage of having his predecessors' work before him, and has been able to refer to the stars themselves for verification and, if need be, correction of his results, it is not probable that these discordances can be due to accidental errors in the Cordoba estimations. In the Notes appended to the Catalogue such cases are carefully pointed out, and discussed whenever sufficient materials existed for the purpose. These Notes will be of great value to our Southern astronomers, and are certain to lead to successful investigation in the interesting field of stellar variation.

The maps published by Dr. Gould are fourteen in number, one of which is a skeleton map showing the proposed revision of the Southern boundaries of the constellations. Each map has been directly compared with the portion of the sky to which it refers before publication, and the greatest care has been taken to reproduce, as closely as possible, the gradations of light over the region of the Milky Way. The position of the Northern Pole of the Galactic Circle is fixed by Dr. Gould at R.A. $12^h\ 41^m\ 20^s$, Decl. North 27° 21′ for the epoch 1875·0. The maps are beautifully executed, and will well repay examination.

The materials collected by Dr. Gould on the Uranometria of the Southern heavens are far more complete and accurate than any which previously existed, and he has, therefore, been naturally led to discuss their bearing on those great questions of the constitution of our stellar universe which offer so fascinating and inexhaustible a field for philosophical speculation.

The results which Dr. Gould has obtained are in general accordance with those of previous investigators on the subject. It appears to be clearly proved that distance is one of the most important factors in producing differences of apparent bright-

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ness in the stars; but the agreement between the number of stars of different magnitudes and the number which might be expected if these changes of apparent brightness depended solely on distance is not perfect over any large range of magnitudes. There appears to be a decided preponderance in the number of the brighter stars. It is possible that this preponderance may be partially due to the conventional scale of magnitudes not being a truly photometric scale; and it is necessary, before any close agreement can be expected between the number of stars of the different magnitudes and those computed on the assumption of distance being the sole factor of variation, that the number of stars in a group should be sufficiently great to insure that the mean intrinsic brightness of the stars of each group should be constant, a condition which can only be secured when a considerable number of stars are included in each group, for there are certainly proved variations of intrinsic brightness amongst the stars in a higher proportion than 300 : 1. But, although Dr. Gould had these possible sources of error before his mind, he has been led, after a careful discussion of his own observations, to infer that the preponderance of the brighter stars is due to the existence of a stellar cluster consisting of some four or five hundred stars, of which our own system is supposed to be a member. The position of the northern pole of the medial plane of this belt of stars has been fixed by Dr. Gould at R.A. 11^h 25^m, N.P.D. 60°, whilst that of the Galactic Circle is at R.A. 12^h 41^m, N.P.D. 62° 39′. That there is a striking crowding of bright stars towards the portion of the heavens to which Dr. Gould calls attention is an undoubted fact, and one which had previously attracted notice. It is also proved by Dr. Gould that the number of stars of the different magnitudes, which remain after the abstraction of the stars of this supposed group, agrees more closely than before with the computed number on the assumption that the changes in brightness depend solely on distance. But whether these facts are sufficient to prove our power of discriminating between the stars of this belt, and that general condensation of matter which gives rise to the appearance of the Milky Way is a point upon which I can form no very positive opinion. I think, however, that the values of annual parallax and of relative brightness, which have been found for some of the stars of this belt show that, if it exists as an isolated cluster, it is one of vast extent and great complexity. Looking out from this mere speck of an Earth on the space which surrounds me, and recognising, as I must, the awful and almost inconceivable distances that separate me from the nearest of the stars, compelled to acknowledge that every one of these twinkling points is as much an independent source of light and heat as our own Sun, that every increase of optical power brings a large proportionate number of other stars into view, and in entire ignorance of the position of my point of view amongst these stars, I feel my inability to firmly grasp the geometrical, much less the

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physical, constitution of such an universe. I cannot conceive space without limits, or the possible nature of a boundary of such space. However much, therefore, my mind may revel for a time and rejoice in its almost unfettered liberty amid such speculations, yet it finds no Mount Ararat upon which to rest the sole of its foot, and it soon gladly returns to the ark of experiment and observation upon which the foundations of our science have been laid, and the superstructure, if slowly, yet securely raised.

Although, therefore, from the constitution of my mind, and training, I am perhaps unable to do full justice to this, the speculative part of Dr. Gould's work, I can speak with the greatest confidence of the value of the observational results contained in the *Uranometria Argentina*. It is a work of very considerable extent; it has been planned with great care; and executed with the most scrupulous attention to details. It will remain an enduring record of the relative brightness of the Southern stars for its epoch; and will be accepted for many years as the chief authority upon questions of their magnitude; and it is certain, from its very success, to incite other astronomers to efforts in the same direction—efforts which must ultimately lead to its being replaced by something more extensive, something even yet more accurate.

No higher praise can, I believe, be given to work of the class. In our science, at least, men do rise "on stepping-stones of their dead selves to higher things." I am certain that the award of this Medal by your Council to Dr. Gould will be received with the greatest satisfaction by the Fellows of this Society, and by practical astronomers of all nationalities, as a fitting tribute to good work done for the advancement of their science.

Earl of Crawford and Balcarres.

My Lord,

Will you forward, through the representative of the Argentine Republic, this Gold Medal to Dr. Benjamin Apthorp Gould, with the assurance of our high appreciation of the skill, energy, and success, with which he has directed the work of the Cordoba Observatory, and our hopes that his efforts for the advancement of our science may be long continued and equally successful in the future?